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SUGAR HILL FIRE STUDY PLOTS

MODOC NATIONAL FOREST

by

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Berkeley, California
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Introduction

One hundred and fifty-five trees were marked for study after the Sugar Hill fire of July 1929, in order to secure pertinent data to aid in marking fire-injured trees for salvage. Marking for salvage in fire-injured stands is one of the most difficult problems facing the administrator of forest areas. If possible, a sufficient number of trees must be left to reseed the burned area, yet those trees that are attractive to insects must be salvaged in addition to the completely fire-killed material. If this is not done conditions will be favorable for the breeding-up of a large insect population in the injured trees, with possible extensive loss in surrounding unburned stands as well as within the burned area. Much of this loss might be averted by salvage of attractive material within the burn. Thus the chief purpose of this study is to find out what types of fire-injured trees are safe risks if left uncut, and what types should be salvaged. In addition it is desired to determine if the entomological causes of death in fire-injured trees differ markedly from those in uninjured stands and to determine the effect of fire injury on the growth rate of trees surviving the fire.

Although it is intended to continue the records for a year or two, the fact that the 1932 infestation shows every indication of being a normal one and apparently has not been influenced by the fire leads us to believe that the information collected up to this time completes the project. Accordingly this may be considered the final report on the project. Reports giving methods and preliminary results have been written by Person[1,2] and Salman[3].

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[1] Person, H.L. Preliminary report on fire study plots, Sugar Hill fire, Modoc Nat. Forest; May 1930. File Typescript.

[2] " Progress Report on fire study trees, Sugar Hill fire, Modoc Nat. Forest; November 1930. File Typescript.

[3] Salman, K.A. Progress Report, season of 1931, Sugar Hill fire study trees, Modoc Nat. Forest; January 1932. File Typescript.

Materials for Study

Fire-injured trees on two plots--one on Lassen Creek and one on Willow Creek in the North Warner District, Modoc National Forest--were classified by Person according to the following classification of injury:

Fire Injury Class	Description
I	No fire injury
II	From 0 to 25% defoliation; no cambium injury.
III	25 to 50% of needles killed; no cambium injury except possibly in spots around old fire scars.
IV	50 to 75% of needles killed; cambium injury--little or none.
V	75 to 100% of needles killed; cambium injury light and spotted or absent.
VI	100% of needles and terminal buds killed and cambium injury severe; fire killed trees.

This classification is similar to that used by Miller and Patterson in previous studies of fire-killed trees. No material was selected for this study from Classes I and VI, as no trees in the former class would be killed by any but a normal infestation, and trees of Class VI would be killed as a direct result of the fire.

Several trees originally marked for study became windfalls and were eliminated from the study. In addition a few records had to be discarded because of incompleteness or other reasons. As a result, of the 155 trees originally marked, 148 supplied data for analysis. The distribution of these trees in their respective fire injury classes is as follows:

Table 1

Class	Trees	Volume
II	33	31,790
III	43	36,940
IV	30	14,960
V	42	22,900

It is seen that there was a relatively even distribution in the four fire-injury classes involved, as far as the number of trees is concerned. Distribution by volume was not so satisfactory, possibly because the fire caused more severe injury to the younger trees, thus placing those having smaller volumes in the more seriously injured classes.

Insect Losses

The following table shows the insects causing death in the various fire-injury classes, from the time of marking in September and October 1929 until October 1932:

Table 2

	Fire Injury Class								Totals	
	II		III		IV		V			
	Tr.	Vol.	Tr.	Vol.	Tr.	Vol.	Tr.	Volume	Tr.	Volume
DB	3	2,020	3	2,990	6	1,350	12	8,660	24	15,020
FH					1	50	6	4,440	7	4,490
DM-FH							2	170	2	170
Totals	3	2,020	3	2,990	7	1,400	20	13,270	33	19,680

It is seen from the above table that the greater portion of the loss was caused by attacks of the western pine beetle, and that the greatest loss was caused in Fire Injury Class V, with Class IV ranking second.

The following table shows the insect loss by years and the distribution of losses in the several fire-injury classes:

Table 3

	Fire Injury Class								Totals	
	II		III		IV		V			
	Tr.	Vol.	Tr.	Vol.	Tr.	Vol.	Tr.	Volume	Tr.	Volume
1929							3	1,760	3	1,760 -
1930			2	2,290	2	550	7	4,670	11	7,510 + 326%
1931	1	250	1	700	5	850	8	5,980	15	7,780 + 340%
1932	2	1,770					2	860	4	2,630 + 49%
	3		3		7		20		33	

This table shows that the first and heaviest losses occurred in Fire Injury Class V, with the heavier losses in all classes coming in the first and second years following the fire. The loss of 1932 is incomplete, as attacks were being made at the time of the examination (October 1932). However, it is not expected that many more trees will succumb in 1932, as the season of insect activity was nearing its close, and a detailed examination of every tree in the study showed no attacks other than those recorded above.

Cambium injury, which is but partially provided for in the classification, may be an important factor in causing a tree to become susceptible to insect attack. Even trees of Classes II and III may suffer some cambium injury, chiefly around old fire scars. If we separate the green and insect-killed trees in the several fire-injury classes into two groups, one having no or light cambium injury and the other having relatively severe cambium injury, the following results are obtained:

Table 4

	Fire Injury Class							
	II		III		IV		V	
	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
Green trees	2	9	27	13	18	5	17	5
Insect-killed trees	2	1	1	2	4	3	7	13
% total trees killed:	8.7	10.0	3.6	13.3	18.2	37.5	19.2	72.2

We may consider the relationships within each class as shown above due to the effects of the cambium injury, for the amount of variation of foliage injury within any given class is relatively small.

Tree Growth

The following table shows the growth of the trees in the various fire-injury classes. Growth is given in hundredths of a millimeter. Trees in each fire-injury class are separated into green trees remaining in 1932 and those killed in 1929, 1930, 1931 and 1932 by insects.

Table 5

Year	1925	1926	1927	1928	1929	1930	1931	1932
Fire Injury Class II								
Green Trees, Basis 31	48.7	51.8	46.7	50.0	38.9	49.9	76.3	69.0
1931 Basis 1	12	32	14	37	25	32	31	--
1932 " 2	38.0	56.5	47.0	50.0	39.5	29.0	54.0	45.0
Fire Injury Class III								
Green Trees, Basis 31	69.1	70.4	60.2	74.8	63.2	58.7	76.3	75.7
1930 Basis 2	12	13.5	19.5	17.0	11.5	6.5	--	--
1931 " 1	54	49.0	42.0	57.0	50.0	38.0	77.0	--
Fire Injury Class IV								
Green Trees, Basis 23	71.8	70.3	70.2	72.3	68.0	51.5	60.5	66.8
1930 Basis 2	46.5	55.5	46.0	69.0	66.0	33.0	--	--
1931 " 5	58.6	58.6	56.2	60.8	53.2	63.8	54.6	--
Fire Injury Class V								
Green Trees, Basis 22	63.8	75.3	60.9	73.8	70.5	52.1	55.4	59.2
1929 Basis 3	44.0	53.0	30.7	37.0	31.0	--	--	--
1930 " 7	32.4	35.3	32.1	36.0	27.1	16.8	--	--
1931 " 8	55.0	39.7	40.4	54.4	43.0	39.0	23.7	--
1932 " 2	59.5	50.5	53.5	76.5	80.5	68.0	66.5	52.0

Discussion

Table 2 shows no unusual amount of damage caused by flathead borers or other secondary insects. Although flathead and roundhead borers were active in areas of fire-killed cambium and extended the areas to some extent, this activity did not result in the death of the trees except where the western pine beetle entered into the infestation. Accordingly this activity, although contributing to the weakening of the trees, cannot be considered a direct cause of death. The only logical conclusion that can be drawn from the figures given in Table 2 and from observations is that the fire had little effect in changing the composition of the infestation. The usually predominant western pine beetle remained predominant, and the secondary insects filled their customary niche in the infestation, as represented by insect-killed trees.

Table 3 shows that the heavier losses occurred in the two years immediately following the fire. The decrease in the 1932 infestation, in connection with observations in surrounding areas, would seem to indicate that losses of 1932 and thereafter would be typical of current infestations and could not be linked directly with the fire injury. In addition, the fact that the remaining green trees in all fire-injury classes have shown a marked recovery in growth and a marked reaction to environmental conditions can be interpreted as supplementary evidence of the return to normal. Tables 2 and 3 both show that in general insect losses in the various tree classes varied directly with the amount of injury. Figure 1 shows the losses in the tree-injury classes on a tree basis. The chief point to be noted in this graph is the wide spread between the losses in Classes II and III, and IV and V. The two first-named classes each suffered a total loss of less than one-tenth of the total, while Class IV suffered a loss of nearly one-quarter of the trees in the class. Almost one-half the number of trees in Class V were killed. The data given above concerning insect losses bears out the logical conclusion that those trees more severely injured by fire are more likely to succumb to insect attack. If we consider cambium injury in addition to foliage injury, we find that the former is responsible for the greater portion of the loss in Class V, but that the loss in both types of trees in this class is great enough to justify cutting for salvage. We also find that those trees in Class IV having cambium injury in addition to foliage injury should be cut. Loss in the other trees of Class IV in which little cambium injury occurred was found to be about 20 per cent in the two years following the fire. Cutting of these trees, as well as salvage of cambium-injured trees of Class III might not be advisable.

The trees that should be salvaged on any given fire area will of course depend on conditions peculiar to that fire. If a large stand is left and there is plenty of material of the less injured classes on hand, salvage will include more or less seriously injured trees than if only trees having a more serious type of injury were left by the fire. If we can consider the data secured by this study sufficient, however, it would appear that in most cases all trees in Class V and the cambium-injured trees of Class IV should be cut for salvage. Cutting in the other classes would depend on the type of stand left by the fire.

Conclusions

It does not seem advisable, because of the limited amount of material included in this study, to consider the results conclusive. The information secured does, however, give a good impression of the conditions that followed in the wake of this particular fire. It also supplies general information regarding the effects of fire on subsequent insect infestations that will be of aid in salvage operations on other fires.

The conclusions reached as a result of this study may be stated as follows:

1. The composition of infestations following the Sugar Hill fire was not markedly different from the normal composition of infestations in uninjured stands of the same type as that influenced by the fire;

2. One type of insect activity by secondary insects that could be linked directly with the fire was the enlargement of fire-killed cambium areas. This type apparently did not contribute noticeably to the infestation as represented by insect-killed trees;

3. Trees in the more seriously fire-injured tree classes are more susceptible to subsequent insect attack than the less seriously injured trees;

4. In general, susceptibility of trees suffering from foliage injury alone varies directly with the amount of defoliation, and the figures indicate that a maximum loss of about 20% of the stand in Class V, the most seriously injured class included in the study, will occur;

5. The susceptibility of trees suffering from cambium injury in addition to foliage injury is markedly greater than that of trees suffering from foliage injury alone. Losses in Class V trees suffering from both types of injury reached nearly three-fourths of the total number of trees studied in that class;

6. Available information indicates the susceptibility of the various fire-injury classes to insect attack to be about as follows, the list progressing from the less susceptible types to the more susceptible types:

Class	Injury
II -	No cambium injury; 0-25% defoliation
III -	No cambium injury; 25-50% "
II -	Cambium injury; 0-25% "
III -	Cambium injury; 25-50% "
IV -	No cambium injury; 50-75% "
V -	No cambium injury; 75-100% "
IV -	Cambium injury; 50-75% "
V -	Cambium injury; 75-100% "

7. Salvage operations will depend entirely on the conditions occurring on any given fire. The results of this study, however, indicate it to be advisable to salvage cambium-injured trees of Class IV and all trees in Class V. Further salvage in the less seriously injured groups will depend entirely on the composition of the living stand left on the ground after the fire.

8. This fire, which occurred in July 1929, apparently exerted no influence on tree growth in that year. Growth in 1930 was depressed below the normal for the general region in which the fire occurred, and later recovery of green trees was more delayed in the more seriously injured trees. Insect-killed trees in general showed abnormal growth and trends. In several cases they appear to be correlated with the fire injury of 1929. In other cases the trees that succumbed were, according to our present ideas, extremely susceptible before the fire. This is shown graphically by Figs. 3-6.

Fig. 1

LOSSES IN FIRE INJURY CLASSES

TREE BASIS

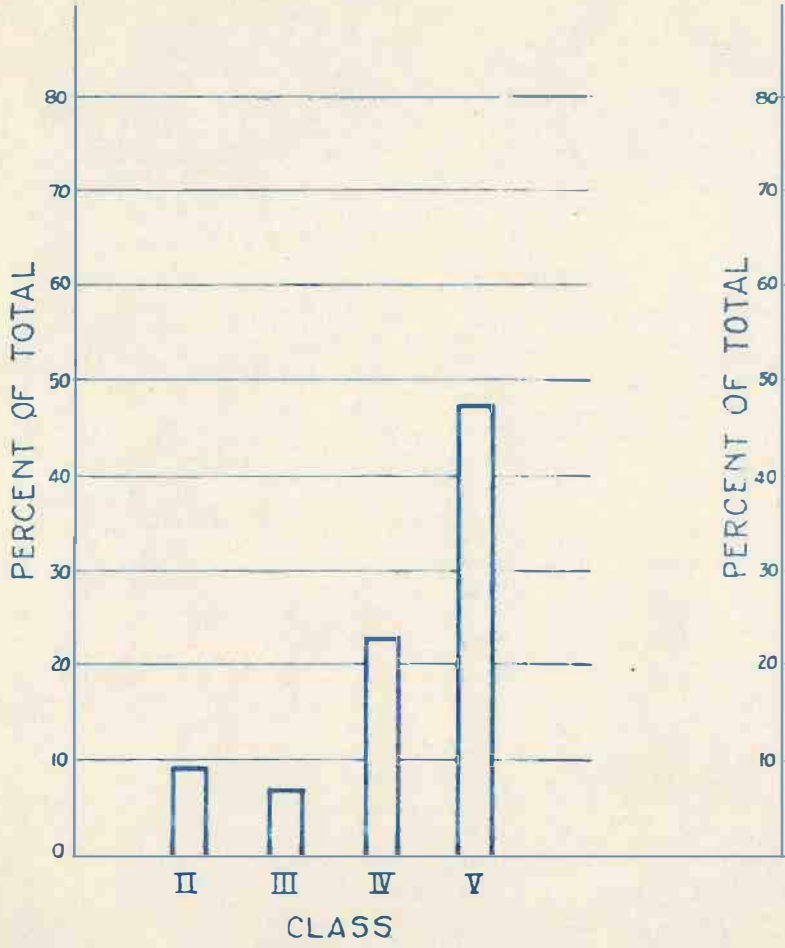

Fig. 2

CAMBIUM INJURY AND INSECT LOSSES

TREE BASIS

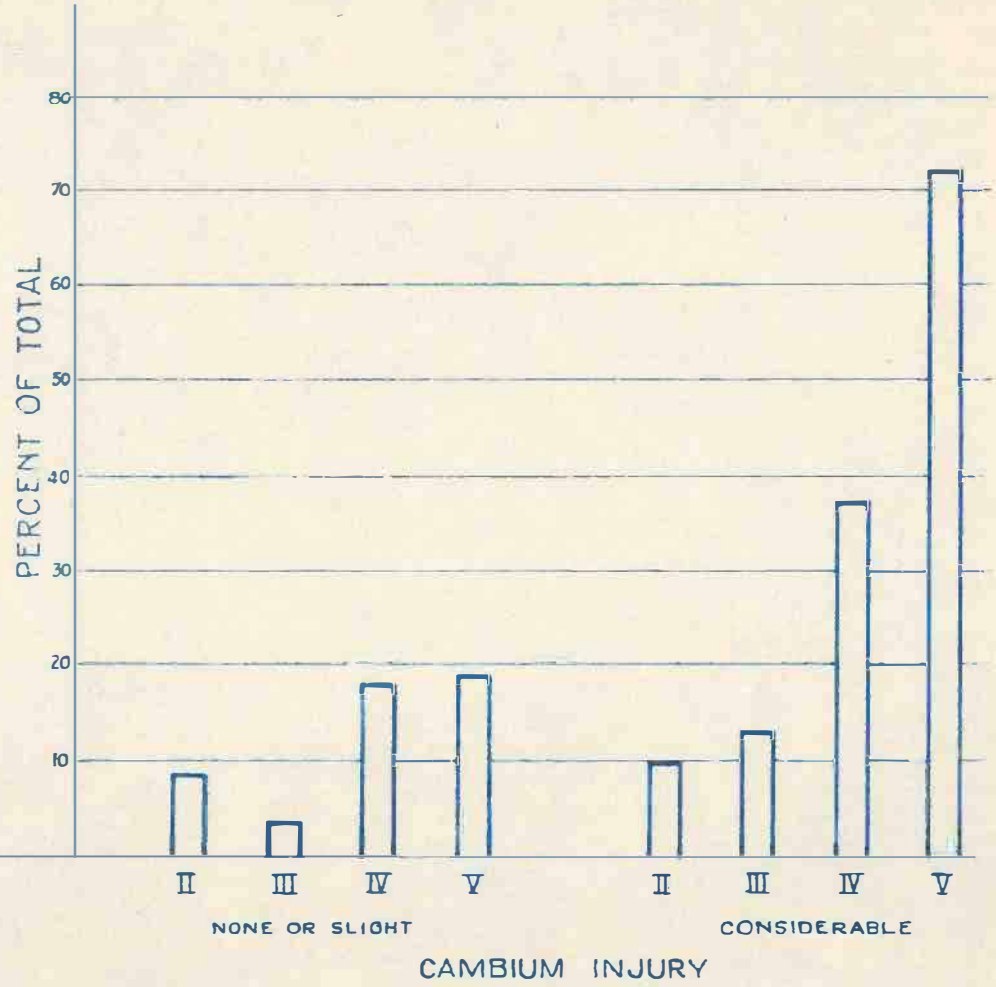

FIG. 3

FIRE INJURY - CLASS II

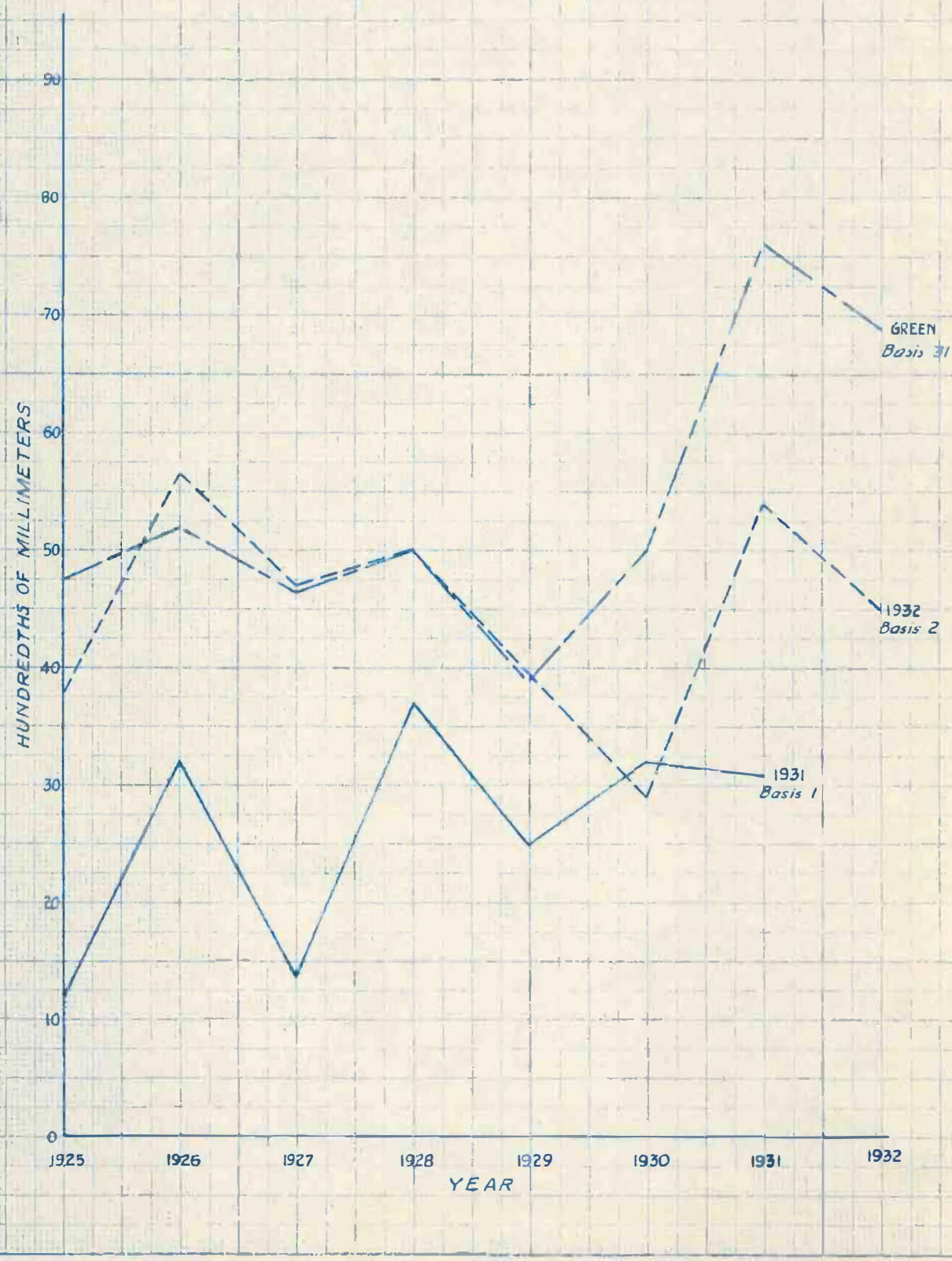

FIG. 4

FIRE INJURY – CLASS III

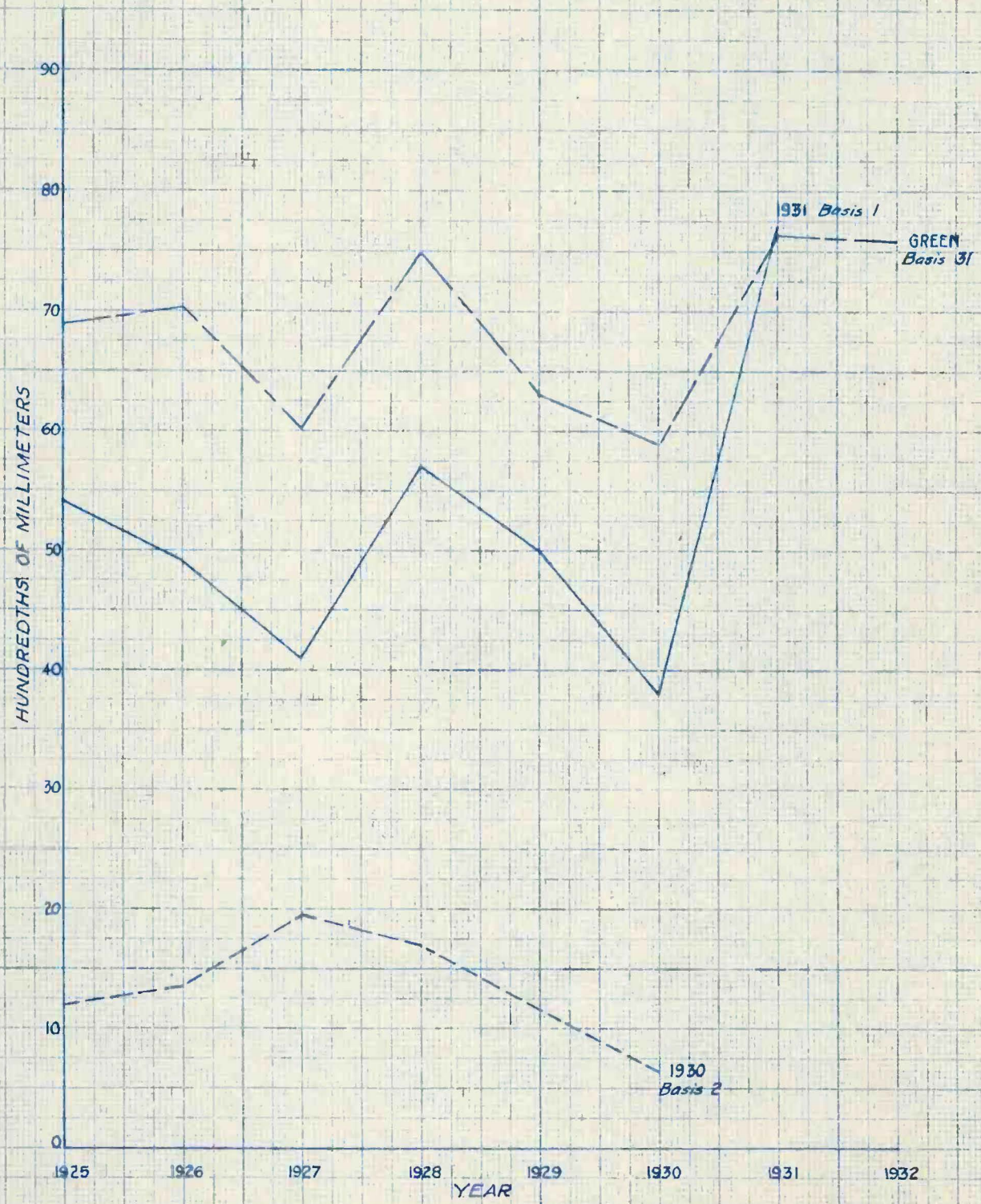

FIG. 5

FIRE INJURY - CLASS IV

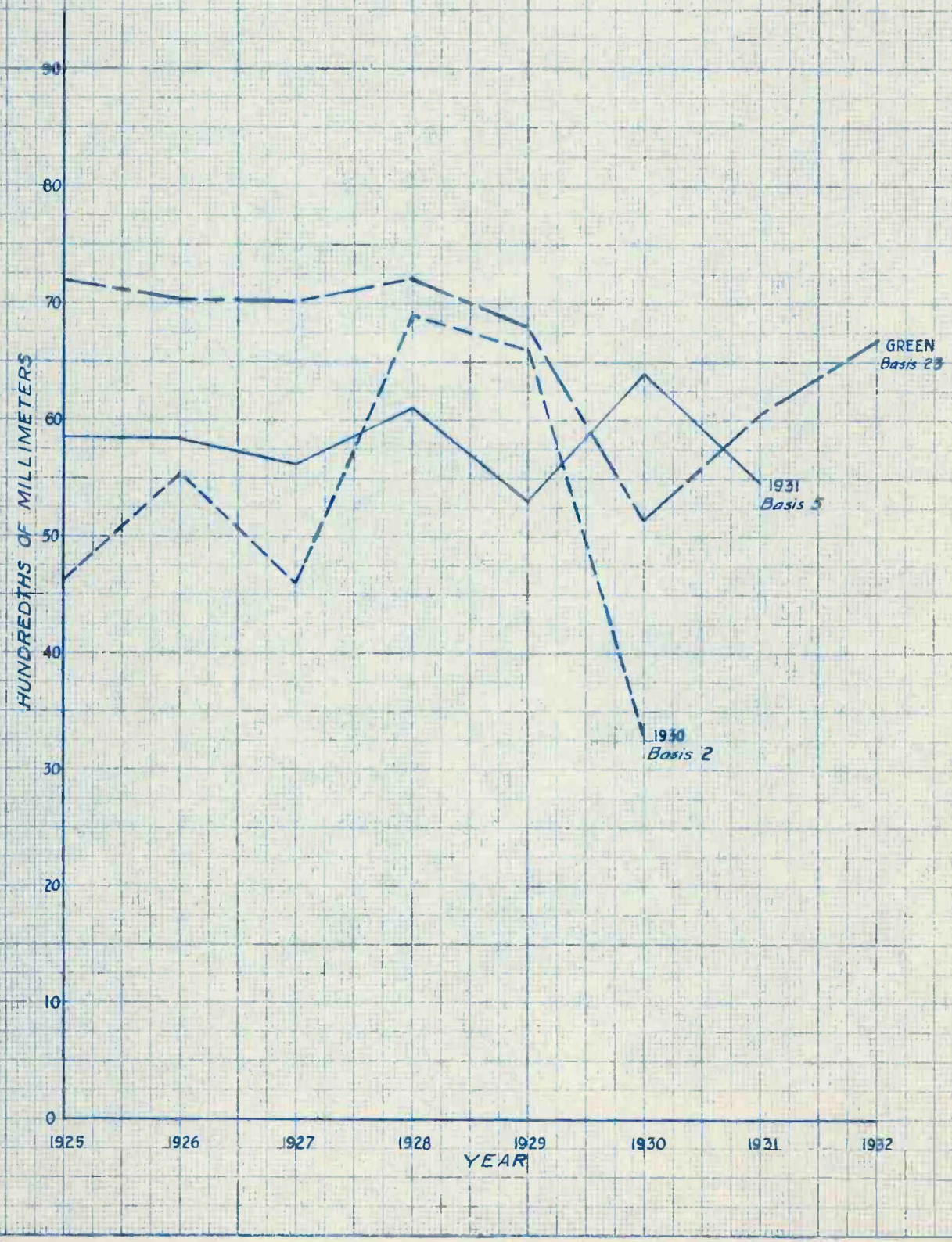

FIG. 6

FIRE INJURY - CLASS V